

# TALKING TRASH II: A RETURN TO DEBRIS REMOVAL

*J. F. Sadler, Jr.*  
*CELRN-EP-D*  
*(615)736-5665*

## INTRODUCTION

The accumulation of floating drift and debris is a universal problem.



FIGURE 1 - TYPICAL DEBRIS BUILD-UP NEAR LAKE CUMBERLAND, KY

This paper investigates three specific problem sites, identifies the problem and cause, and discusses remedial measures and their effectiveness. The three sites are:

### CHEATHAM POWERHOUSE

The Cheatham Project is a combined lock/dam/powerhouse located downstream of Nashville, Tennessee on the Cumberland River. Water flow passes through the powerhouse with approach velocities sufficient to draw waterlogged trash and floating debris onto the intake trash racks. Consequently, trash accumulates on the racks and floor of the forebay. This clogging reduces efficiency of the

turbines resulting in lost revenues from lower power generation capability.

## HUNTSVILLE SPRING BRANCH

Huntsville Spring Branch is a tributary of the Tennessee River that receives the watershed of Huntsville, Alabama. During periods of high rainfall and/or elevated flows, trash and debris wash into the stream and are carried through metropolitan Huntsville into Redstone Arsenal and Wheeler Wildlife Refuge. The backwaters of the Tennessee River catch and deposit floating debris all through this once pristine environmental habitat.

## LAKE CUMBERLAND

Lake Cumberland is the water reservoir impounded by Wolf Creek Dam near Somerset, Kentucky. Similar to Huntsville Spring Branch, during periods of high rainfall and/or elevated flows, trash and debris wash into the stream and are carried through rural Kentucky. Woody debris as well as cultural waste deposit along the river banks, at Cumberland Falls, and ultimately Lake Cumberland. In addition, large floating wood rafts present a hazard to navigation on the lake.

## CHEATHAM POWERHOUSE

### BACKGROUND

Cheatham Powerhouse was built in 1958. It contains three Kaplan-type turbines rated at 21,400 hp capable of generating 12,000 kw each. The turbines have a design head of 22 feet and an operating speed of 60 rpm. Due to the accumulation of debris and subsequent head loss, a trash boom was provided in front of the powerhouse in 1963. The boom was successful in preventing floating trash from reaching the power intake, but ineffective in catching the waterlogged material that washed under the boom. Floating debris was periodically flushed through spillway gates to reduce safety and operating problems at the project. Debris that was too large or waterlogged was dredged out biannually using floating plant. The debris was loaded onto a barge, floated upstream then unloaded and secured on the river bank. Due to the manpower and floating plant expense, alternative methods of cleaning and disposal were investigated. Nashville District personnel visited self-cleaning trashrack installations and were favorably impressed.

### DESIGN CRITERIA

The system was designed to lift a diversified collection of debris ranging from refuse, bottles and other small items to entire trees. Several trash removal systems were evaluated and

deemed too limited in their applicability. The system chosen for removing trash from the turbine intake areas utilized water

velocity to move the debris toward the trashrack and then teeth or pins on motor driven chains would lift the trash (both submerged and floating) to the conveyors and subsequently to a collection area. The continuous operation enhanced the system effectiveness. Debris bound on lifting pins would be released from that pin and lifted by a subsequent pin. The racks had to be large enough to cover all three intakes, approximately 60 feet high by 25 feet wide. Conceptual layouts of the system and preliminary computations assured that self-cleaning trashracks could be constructed large enough for this project.

## SPECIFICATIONS

The RFP required a 50% design submittal with the successful bidder responsible for final design. The trashrack was to lift a 36" diameter, 60 foot long log as well as mats comprised of debris such as vegetation, bottles and tires. The trashrack was required to operate continuously with a reset feature that would allow oversized material to be released from binding. A conveying system which would move the lifted debris to a collection bin was also required. The one rigid requirement for these trashracks was painting. The high degree of abrasion as well as the continuous submergence of the trashracks were our main concerns. The Construction Engineering Research Laboratory (CERL) recommended an initial coat of zinc-rich vinyl and subsequent coats of vinyl with added abrasives.



FIGURE 2 - DUPERON SELF-CLEANING DEBRIS REMOVAL SYSTEM

## PROPOSAL

Initial proposals were submitted on 13 April 1990. The Duperon Corporation of Saginaw, Michigan was issued a Notice To Proceed on 10 December 1990 with a 420 calendar day completion period. The trashracks were completed in February 1992 at a total construction cost of \$5,140,000.

## DESIGN

### **Structural**

The Duperon Corporation subcontracted Spicer Engineering as their structural consultant. They were responsible for the design of the main trusses, horizontal and inclined conveyors, face racks, foundation design, anchorages and concrete trash storage bin. The steel members were designed in accordance with A.I.S.I. standards.

### **Mechanical**

The trashrack driveshafts, driveshaft bearings, hydraulic equipment and chains were designed by Duperon Design Incorporated. The shafts were evaluated for loading, stress, deflection and fatigue. The bearings were designed for a 100 year continuous use life. The hydraulic system was designed with over-pressure protection. The chains were designed to individually withstand the entire maximum load based on over-pressure.

### **Electrical**

Schwarderer and Associates, the electrical design firm, provided the following:

- Trashrack operation sequence
- Electrical layout and conduit list
- Wiring diagrams for the control system with integrated programmable logic controller (PLC)
- Control panels layout and detail drawings
- Computations for motor feeder circuit conductor, motor branch circuit breakers, motor control center main breaker and circuit voltage drop
- Annunciation and alarm management scheme

- PLC ladder diagram



## CONSTRUCTION

### **Prototype**

One of the superior points of the Duperon Corporation submittal was the proposal to build a prototype trashrack prior to fabrication. This allowed the Corps to verify the workability of the Duperon design. The Duperon Corporation was able to substantiate dimensional tolerances for the trashracks from the prototype.

### **Fabrication**

All steel was fabricated in the Saginaw, Michigan area. Prior visits by Nashville District personnel to local machine shops established their capabilities. The initial quantities of steel were estimated to be one million pounds. However, this escalated to 1.4 million pounds by the end of fabrication.

### **Assembly**

After fabrication the material was moved to a local assembly area 16 river miles upstream of the project. This required 34 truck trips. All of the racks as well as the conveyor were assembled here. The hydraulic drives were also mounted at this time as well as the lifting chains. Approximately 25,000 feet (5 miles) of chains were used on this system. One section was operated prior to site delivery. This section successfully lifted two test logs of the specified diameter.

### **Erection**

All of the material was moved from the assembly area to the erection area via barge. Six barges were required to move this material. Erection was facilitated via a barge-mounted crane. Divers set mounts on the inlet forebays and then guided the individual trashrack sections to the mounts. After this operation was completed, the horizontal conveying rack sections were placed. A concrete trash storage bin and the electrical wiring and controls were installed concurrent with those operations.

### **Acceptance Test**

An operational test was required prior to acceptance. The trashrack system had to lift the design log from the river and convey it to the storage bin. The system substantially met the required RFP acceptance criteria in February 1992.

## SUMMARY/ LESSONS LEARNED

After installation, the Self-Cleaning Trash Racks performed with mixed success. The specifications required the trash racks to remove a broad range of debris with vastly different sizes. This caused operational difficulties in some small debris passing through the trash screens and binding the lifting chains. Modifying the chain guards alleviated this binding. The conveyor system also had jamming problems due to the sharp elevation angle. Conveying the debris riverward instead of landward removed the sharp angle. Disposal of stockpiled debris became major expense. Due to excessive maintenance costs, the system was removed in January 1996.

## HUNTSVILLE SPRING BRANCH

### BACKGROUND

Huntsville Spring Branch watershed drains about 86 square miles of municipal Huntsville, Alabama and the surrounding Madison County. The drainage deposits debris into Redstone Arsenal, Wheeler Wildlife Refuge, and ultimately Wheeler Reservoir. The deposits detract from the natural aesthetics, adversely affect river hydraulics, increasing flooding, and destroy wildlife. The Energy and Water Development Appropriations Act of 1995 (Public Law 103-316) provides the legal authority for this project.

### PROBLEM IDENTIFICATION

This problem was first documented in 1971 at a meeting between Redstone Arsenal personnel and City of Huntsville employees. In September 1994, a General Investigation study of the Huntsville area identified a potential federal interest in the environmental restoration of Huntsville Spring Branch. In assessing typical site conditions for potential remediation, a typical 20-foot by 20-foot section was selected for debris composition analysis within Redstone Arsenal. The composition of the debris is shown in Table 1.

Type of Debris	Percentage by Number
Plastic Containers	12.8%
Styrofoam Cups	18.4%
Styrofoam Pieces 5"x7"x2.5"	6.4%
Hard Plastic Items	6.4%
Glass Containers	20.0%
Aluminum Cans	34.4%
Tires	1.6%

TABLE 1 - DEBRIS COUNT

This debris count excludes the woody matter which is assumed to comprise of 90% of the total volume.

#### DESIGN CRITERIA

The system is required to remove 90% of debris in a cost effective, environmentally acceptable manner. This will achieve flood control and hazard reduction on Huntsville Spring Branch as well as wildlife habitat restoration and quality of life protection on Redstone Arsenal. In November 1997, The City of Huntsville considered five removal options and selected a passive screen across the channel that will direct debris to a self-cleaning trashrake. Debris will be deposited on the stream bank for removal by city maintenance personnel.

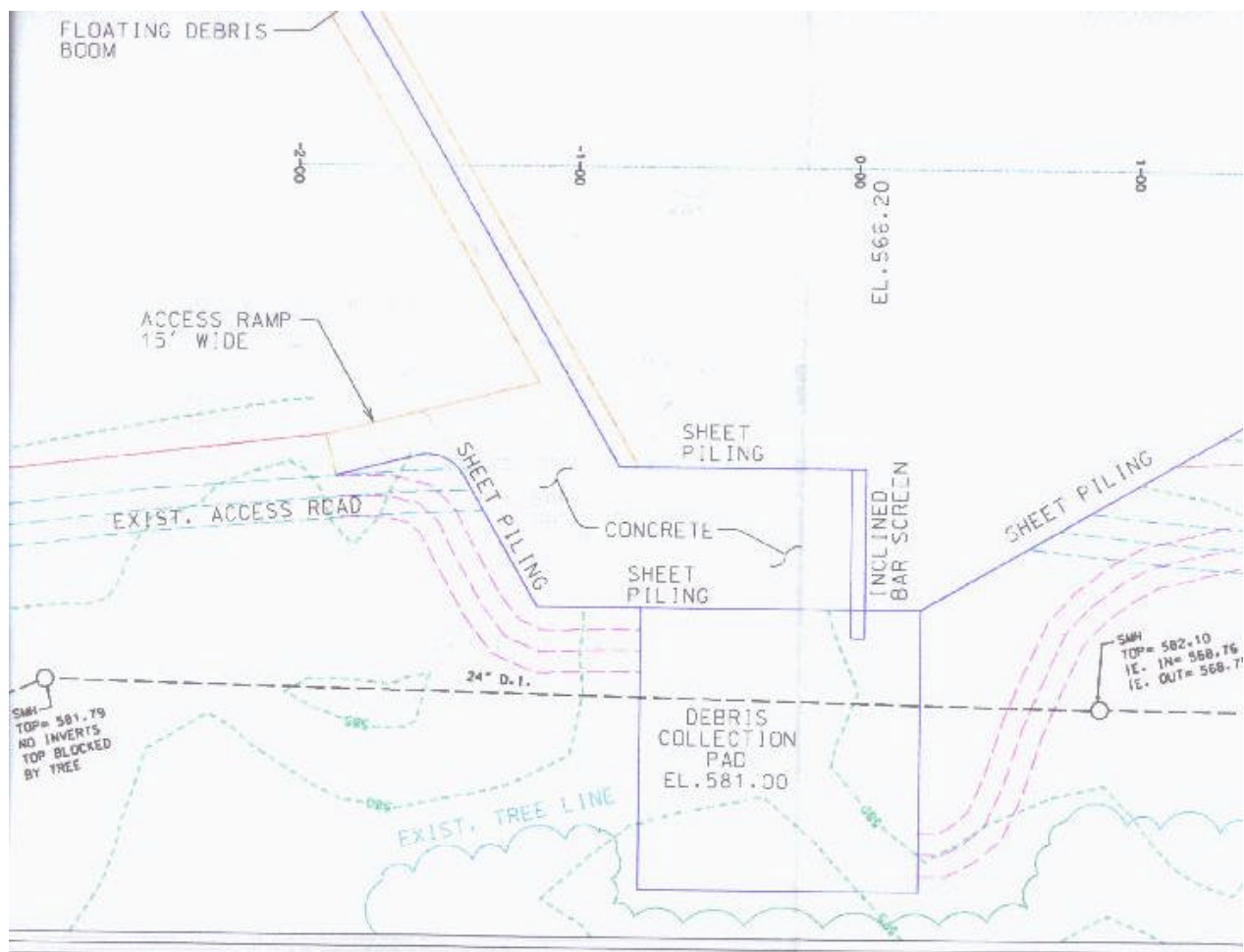


FIGURE 3 - SELECTED HUNTSVILLE DEBRIS COLLECTION OPTION



## SPECIFICATIONS

A floating boom will be constructed in the stream to collect debris. The buoyant boom will be connected to vertical pipe supports with low friction attachments to allow capture of debris at various flood events. The boom is sufficiently angled to the current allowing the flowing water of the stream to force the captured debris to the self-cleaning debris rake.

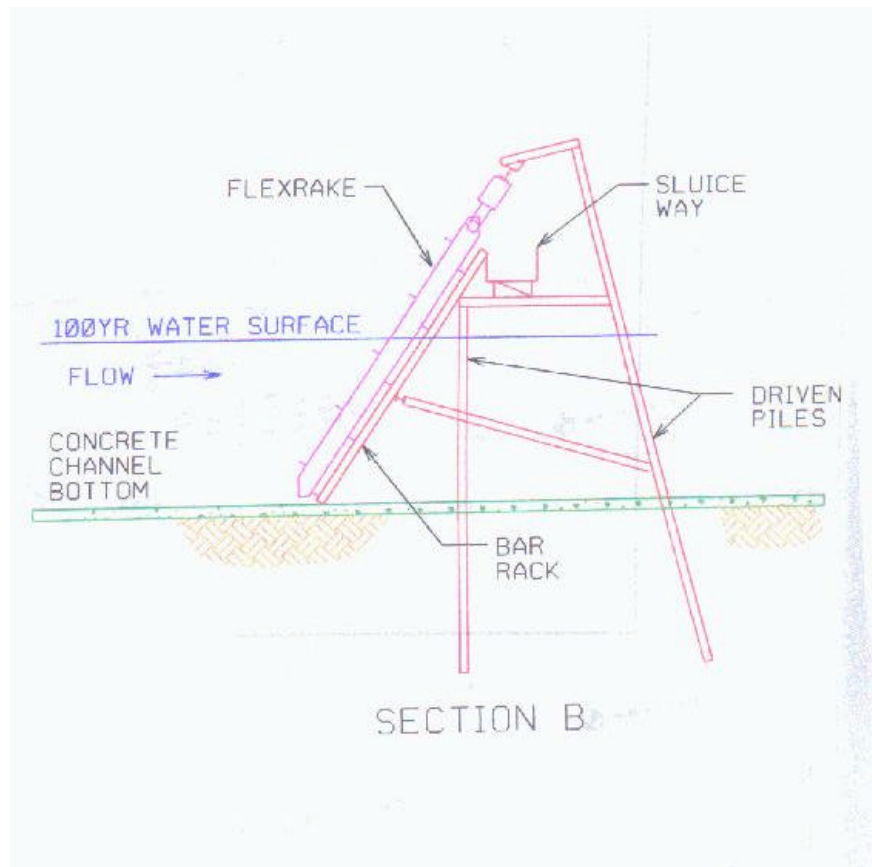


FIGURE 4 - ELEVATION OF TRASHRAKE

The rake removes the debris from the water and deposits it into a sluiceway leading to a debris collection area. Maintenance personnel sort the removed material for disposition. A weir is designed for the other side of the stream to allow overflow in case of damming of the boom and trash rake.

## CONSTRUCTION

Construction is tentatively scheduled for FY 1999, contingent on project approval.

## SUMMARY/ LESSONS LEARNED

Based on the Corps' experience at the Cheatham Project, the trashrake is considered appropriate for the anticipated debris at this site. Additionally, a flume to transport the raked debris to a staging area will reduce binding that was exhibited at Cheatham.

## LAKE CUMBERLAND

### BACKGROUND

The Cumberland River watershed drains about 1,653 square miles of rural eastern Kentucky including Whitley, Knox, Bell, and Harlan Counties. This drainage accounts for approximately 25% of the total Lake Cumberland watershed. The deposits detract from the natural aesthetics, adversely affect river hydraulics, increasing flooding, and destroy wildlife much like Huntsville Spring Branch. Floating debris endangers navigation of Lake Cumberland by commercial and recreational boat traffic. The Energy and Water Appropriations Act of 1998 (House Resolution 2203) provides authority and funding for this project.

### PROBLEM IDENTIFICATION

The upper Cumberland River has long been a rustic wilderness area fraught with pollution. Rural Appalachia historically disposed its waste in areas common to living habitat. The river would take farm developed waste downstream, away from living areas. Natural attenuation would reduce this degradable waste to an unnoticeable volume. As these rural communities grew and developed, larger numbers of inhabitants disposed of not only degradable waste but also nondegradable waste such as glass, plastics, and metals. This, added to woody debris from eroding shorelines during flood events, results in environmentally damaging pollution and endangers river and lake navigation.

In June of 1997, a team of Corps professionals and special consultants spent several days evaluating the problem and researching potential debris removal locations on Lake Cumberland and the upper Cumberland River. Consistent with the previous paragraph, the team found debris blockades on bridge piers, inaccessible boat landings due to trash buildups, and illegal dumps. As the goal of trash interception is to capture trash before it enters Lake Cumberland, and noting that the Cumberland River winds through a gorge and is a protected Wild and Scenic River immediately upstream of the lake, the best site was deemed downstream of the Highway 204 bridge. Ample land is available as well as favorable river hydraulics.





## DESIGN CRITERIA

The system is designed to remove debris in a cost effective, environmentally acceptable manner. This will achieve flood control and waste reduction on the Cumberland River as well as floating hazard reduction on Lake Cumberland. Conceptual layouts of the system and preliminary computations assured that the "trash gate" would be effective at this location.

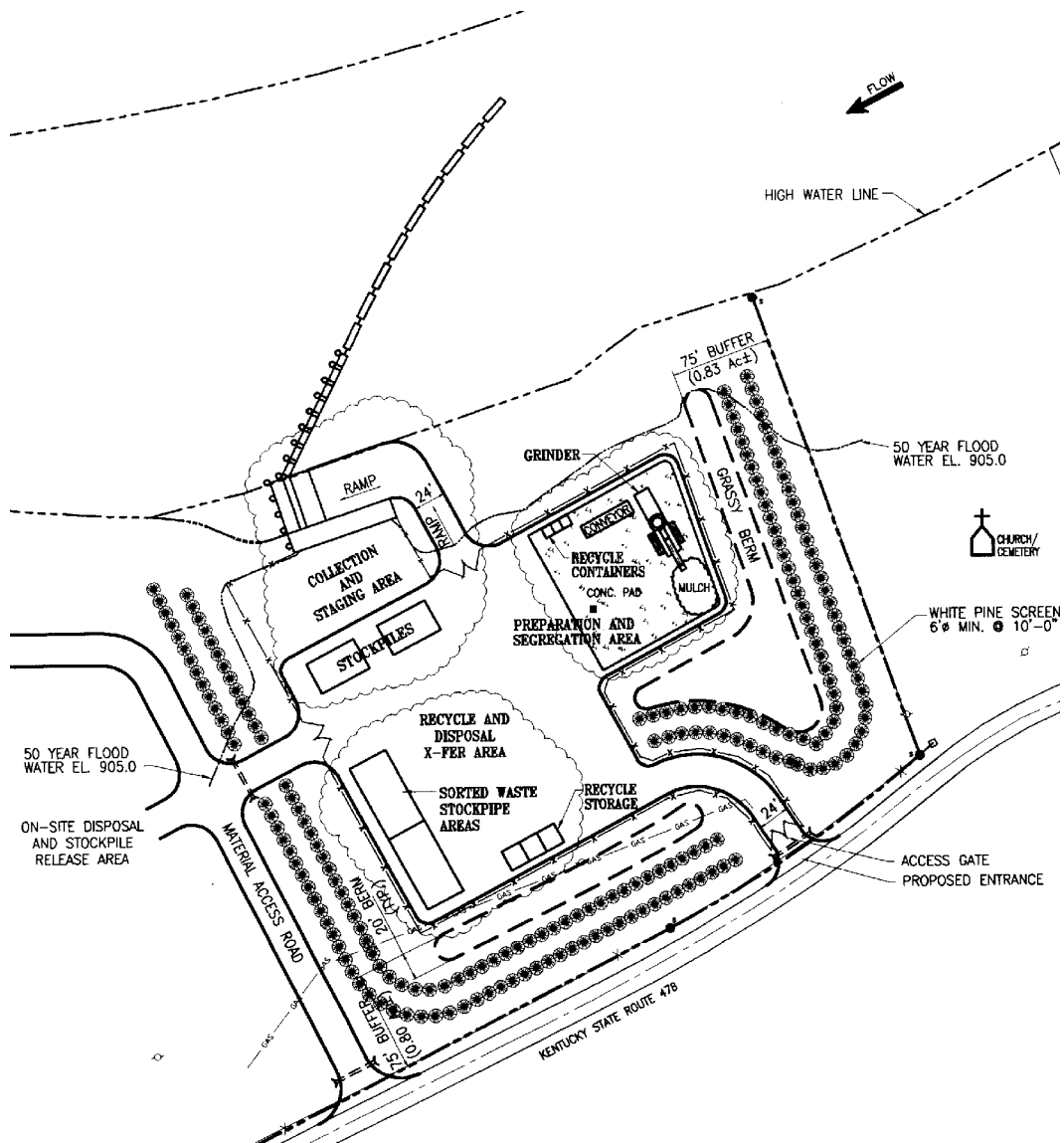


FIGURE 5 - LAKE CUMBERLAND DEBRIS MANAGEMENT CONCEPTUAL DESIGN

## SPECIFICATIONS

The system consists of a fixed glance rack extending approximately 100 feet into the Cumberland River at a thirty degree angle to the flow.



FIGURE 6 - CONCEPTUAL RENDERING OF PROPOSED COLLECTION SYSTEM

The rack extends an additional 130 feet up the bank to collect to about the 10-year flood event. Above that flood event, the flood plain is quite expansive and debris tends to spread out. After flood events, a removal device, such as a trackhoe, will remove the collected debris and deposit it into a staging area. The debris will then be sorted and dispositioned. Some of the woody debris will be either mulched for volume reduction or cut into firewood. Garbage and recycling bins will be provided for the cultural waste. A management plan for potential hazardous waste is being developed. An optional floating glance boom could enhance the capture effectiveness, dependent on model results.

## CONSTRUCTION

Construction is tentatively scheduled to start summer 1998, contingent on real estate acquisition.

#### SUMMARY/ LESSONS LEARNED

Based on the Corps experience at the Cheatham Project, the glance rack is considered appropriate for the anticipated debris at this site. The staging area will allow efficient cleaning and disposition of the collected debris.

#### POINT OF CONTACT

Mr. James F. Sadler, Jr., P. E.  
USACE, Nashville District  
P.O. Box 1070  
Attn: CEORN-EP-D  
Nashville, TN 37202-1070  
(615)736-5623/5665  
CORPSMAIL: JAMES.F.SADLER.JR@USACE.ARMY.MIL